DECLARATION

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[DOCUMENT NAME] Specification

[TITLE OF THE INVENTION] Solid polymer type fuel cell

[CLAIMS]

[Claim 1] A solid polymer type fuel cell comprising a cell stack including: a hydrogen ion conductive polymer electrolyte membrane; a pair of electrodes sandwiching said hydrogen ion conductive polymer electrolyte membrane; and a pair of conductive separators having a gas flow channel for supplying and exhausting a fuel gas to and from one of said electrodes and a gas flow channel for supplying and exhausting an oxidant gas to and from the other electrode,

wherein a junction of at least one of the fuel and oxidant gas flow channels of said conductive separators with an inlet manifold is positioned above a gas supply pipe connected to said manifold in the gravity direction.

[Claim 2] The solid polymer type fuel cell in accordance with claim 1, wherein said conductive separators are arranged parallel to the gravity direction.

[Claim 3] The solid polymer type fuel cell in accordance with claim 2, wherein said inlet manifold has a vertically oriented shape.

[Claim 4] The solid polymer type fuel cell in accordance with claim 2 or 3, wherein a junction of said gas supply pipe with said inlet manifold is positioned below the

center of said manifold.

[Claim 5] The solid polymer type fuel cell in accordance with any of claims 1 to 4, wherein a junction of at least one of the gas flow channels of said conductive separators with an outlet manifold and a junction of a gas exhaust pipe with said outlet manifold are positioned in a lower part of said outlet manifold.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field to Which the Invention Belongs]

The present invention relates to a fuel cell using a solid polymer electrolyte for use in portable power sources, electric vehicle power sources, domestic cogeneration systems and the like.

[0002]

[Prior Art]

A fuel cell using a solid polymer electrolyte causes an electrochemical reaction between a fuel gas containing hydrogen and a fuel gas containing oxygen such as air to simultaneously generate electric power and heat. It essentially includes a polymer electrolyte membrane for selectively transporting hydrogen ions and a pair of electrodes sandwiching the polymer electrolyte membrane. Each of the electrodes includes a catalyst layer mainly composed of carbon powder carrying a platinum group metal catalyst thereon and a gas diffusion layer having both gas permeability and

electron conductivity formed on the outer surface of the catalyst layer.

[0003]

In order to prevent the supplied fuel gas and oxidant gas from leaking out or the two kinds of gases from mixing together, a gas seal or a gasket is arranged to sandwich the polymer electrolyte membrane on the periphery of the electrodes. The gas seal or the gasket is integrated in advance with the electrodes and the polymer electrolyte membrane. This is called an MEA (electrolyte membrane electrode assembly). Outside the MEA, a conductive separator is arranged to mechanically secure the MEA and electrically connecting the MEA with an adjacent one in series. In part of the separator contacting the MEA, a gas flow channel is formed to supply a reaction gas or exhaust generated gas or excessive gas to and from the electrode surface. The gas flow channel may be provided independently of the separator, but in general, a groove is formed on the surface of the separator to be functioned as the gas flow channel.

[0004]

To supply the reaction gas to the groove, a gas supply pipe is diverged into branches in a number corresponding to the number of the separators used, and a piping jig for directly connecting the branches to the grooves of the separators is necessary. This jig is called a manifold, and the above-described type, which directly connects the

supply pipe of the reaction gas, is called an external manifold. A manifold having a simpler structure is called an "internal manifold". The internal manifold consists of through-holes that are formed in the separators having the gas flow channel. These holes are connected to the inlet and outlet of the gas flow channel, and the reaction gas is supplied directly from these holes.

[0005]

Since a fuel cell generates heat during operation, it is necessary to cool the cell to keep it in a good temperature condition. In general, a cooling section through which a cooling medium is passed is inserted between the separators every one to three cells. In most cases, the cooling section is provided by forming a cooling medium flow channel on the rear surface of the separator. To form a common cell stack, these MEAs, separators and cooling sections are alternately stacked to form a stack of 10 to 200 cells. The stack is sandwiched between end plates with the intervention of a current collector plate and an insulating plate, and is secured with fastening rods at both ends.

[0006]

[Problem That the Invention Is to Solve]

As the polymer electrolyte membrane of the fuel cell of this kind, a perfluorosulfonic acid material is used. Since this polymer electrolyte membrane exhibits ion conductivity when it contains moisture, the fuel gas and the

oxidant gas usually need to be supplied in a humidified state. Also, water is produced in a reaction on the cathode side. Thus, if a gas humidified to have a dew point higher than the operation temperature of the cell is supplied, condensation occurs in the gas flow channel inside the cell or inside the electrode, thereby causing a phenomenon such as water clogging. This results in a problem of unstable cell performance or deteriorated performance. Such a phenomenon caused by too much moisture, in which deterioration in cell performance and unstable operation occur, is generally called flooding phenomenon. If this phenomenon occurs on the anode side, shortage of the fuel gas occurs, which is a fatal problem to the cell. If a load current is forcibly produced in a state where the fuel gas is lacking, carbon carrying thereon the anode-side catalyst reacts with water in the atmosphere, in order to generate electrons and protons in such a state of fuel lack. Accordingly, carbon is leached from the catalyst layer, destroying the catalyst layer of the anode-side. Therefore, great attention must be paid to avoid the flooding on the anode side.

[0007]

If the fuel cell is used for a power generation system, procedures including the humidification of the supply gas need to be systematized. For the purposes of obtaining a simple system and improving system efficiency thereof, it is preferable to humidify the supply gas to have a dew point as

low as possible. Therefore, in general, the supply gas is humidified to have a dew point slightly lower than the cell temperature in view of avoiding the flooding phenomenon, improving the system efficiency and simplifying the system.

However, in order to achieve higher cell performance, the polymer electrolyte membrane needs to be improved in ion conductivity. For that purpose, it is preferable to humidify the supply gas such that its humidity is close to 100% relative humidity or not lower than 100% relative humidity. In view of durability of the polymer electrolyte membrane, it is also preferable to supply the gas of high humidity.

[0008]

If the supply gas is humidified for supply such that its humidity is close to 100% relative humidity, it is highly likely that the supplied gas will cause condensation in the upstream of the fuel cell stack, and the condensed water may be supplied to the stack in a mist state. If the separator surface is arranged parallel to the gravity direction and the inlet manifold for the gas supply is provided in an upper part of the separator in the gravity direction, the mist gathers and flows into cells which are close to the gas pipe by the gravitational effect. As a result, due to flooding, the performance of these cells deteriorates. Further, if the manifold is not positioned in the upper part in the gravity direction, the mist remains in the manifold, causing a phenomenon of unstable gas supply.

Meanwhile, due to gas consumption and water generation, exhaust gas is completely oversaturated in the stack, so that a two-phase flow of unreacted gas and water flows into the outlet manifold. Thus, if water is not discharged stably in the outlet manifold, a phenomenon of cell performance deterioration or instability occurs.

[0009]

It is therefore an object of the present invention to solve the above problems and provide a fuel cell which allows uniform gas supply to all the unit cells of the cell stack. More specifically, the present invention intends to provide a solid polymer type fuel cell of high reliability which is free from the retention of condensed water in the manifold and capable of supplying the gas stably without deteriorating or destabilizing the cell performance.

[0010]

[Means for Solving the Problem]

A solid polymer type fuel cell of the present invention comprises a cell stack including: a hydrogen ion conductive polymer electrolyte membrane, a pair of electrodes sandwiching the hydrogen ion conductive polymer electrolyte membrane; and a pair of conductive separators having a gas flow channel for supplying and exhausting a fuel gas to and from one of the electrodes and a gas flow channel for supplying and exhausting an oxidant gas to and from the other electrode. It is characterized in that a junction of at least

one of the fuel and oxidant gas flow channels of the conductive separators with an inlet manifold is positioned above a gas supply pipe connected to the manifold in the gravity direction.

The conductive separators are arranged parallel to the gravity direction.

[0011]

It is preferable that the inlet manifold have a vertically oriented shape.

It is preferable that a junction of the gas supply pipe with the inlet manifold be positioned below the center of the manifold.

It is preferable that a junction of at least one of the gas flow channels of the conductive separators with an outlet manifold and a junction of a gas exhaust pipe with the outlet manifold be positioned in a lower part of the outlet manifold.

[0012]

[Mode for Embodying the Invention]

The point of the present invention is that a junction of at least one of the fuel and oxidant gas flow channels of the conductive separators with an inlet manifold is positioned above a gas supply pipe connected to the manifold in the gravity direction. This allows stable gas supply and prevention of condensed water retention in the manifold, thereby avoiding the phenomenon of cell performance

deterioration or instability.

In a conventional fuel cell in which separators are arranged parallel to the gravity direction and a gas supply inlet manifold is formed in an upper part of the separators in the gravity direction, the manifold is generally designed to be horizontally oriented, and a gas flow channel is connected to the bottom of the manifold. Accordingly, when a gas is humidified to a relative humidity close to 100% upon supply, mist is generated by the condensation in the upstream of the cell stack. The mist is concentrated and supplied into the cells on the gas supply pipe side, causing the flooding phenomenon and therefore cell performance deterioration.

[0013]

According to the present invention, the junction of the gas flow channel of the separator with the inlet manifold is positioned above the gas supply pipe connected to the inlet manifold. Thereby, stable gas supply to each unit cell is realized. Specifically, the separators are arranged in parallel to the gravity direction, and the manifold is vertically oriented or has a vertically oriented part when viewed in cross section. Also, the inlet of the gas flow channel is provided in an upper part of the inlet manifold in the gravity direction. Thereby, the mist is prevented from being concentrated and supplied into the cells on the gas supply pipe inlet side, and gas is supplied stably.

If the cross section of the manifold has a

vertically oriented shape, partially condensed water may be retained in the lower part of the inlet manifold in the upstream of the supplied gas flow in the fuel cell stack during long-term operation. In this case, the resultant decrease in the effective cross sectional area of the manifold increases the pressure loss in the whole gas flow channel and the workload required for the gas supply. As a result, the efficiency of the whole system including the fuel cell stack is lowered. Further, due to the flow of the retained water, the gas supply may possibly become unstable. For this reason, the gas supply pipe connected to the manifold is positioned below the center of the manifold, whereby the condensed water is prevented from being retained by making use of dynamic pressure of the supplied gas.

[0014]

Also, in a fuel cell, gas is consumed to generate power, and water is produced in a reaction on the cathode side. Thus, water inevitably flows into the outlet manifold. This holds true particularly when the relative humidity of the supplied gas is close to 100%. Such condensed water and generated water need to be discharged smoothly from the manifold to the outside of the fuel cell stack, in order to ensure stable cell performance. If the cross sectional shape of the manifold is a shape that allows water to be retained, such as a vertically oriented shape, the resultant water retention may cause variations in the gas pressure inside the

cell, thereby making cell performance unstable. Thus, by setting the connecting position of the gas flow channel with the outlet manifold and the gas supply pipe in lower parts of the manifold, and making use of dynamic pressure of unreacted gas flowing into the manifold, the condensed water and generated water are readily discharged into the gas exhaust pipe connected to the manifold.

Hereinafter, embodiments of the present invention are explained with reference to the figures.

[0015]

≪Embodiment 1≫

FIG. 1 is a front view showing a cathode side of a separator according to this embodiment. A separator 1 has an oxidant gas inlet manifold hole 21, an oxidant gas outlet manifold hole 23, a fuel gas inlet manifold hole 22 and a fuel gas outlet manifold hole 24, a cooling water inlet manifold hole 25 and a cooling water outlet manifold hole 26. The separator 1 further includes a gas flow channel 27 comprising two parallel grooves connecting the manifold holes 21 and 23 on the cathode side and another gas flow channel connecting the manifold holes 22 and 24 on the anode side. The portion surrounded by a broken line 28 is a region to come into contact with the electrode.

In forming a cooling section, a composite separator is used instead of the above-described separator serving as both a cathode-side separator and an anode-side separator.

The composite separator is formed by combining a cathode-side separator with a cooling water flow channel on the rear surface and an anode-side separator with a cooling water flow channel on the rear surface such that their cooling water flow channels face each other.

[0016]

FIG. 2 shows a fuel cell including a cell stack in which the above-described separators 1 and MEAs 2 are stacked alternately. The cell stack is sandwiched between end plates 5 with the intervention of a current collector plate 3 and an insulating plate 4, which is secured with fastening rods 6 and nuts 7. In this fuel cell, manifold holes are formed in the MEAs, the current collector plates, the insulating plates and the end plates so as to communicate with the respective manifold holes of the separator. These manifold holes constitute inlet and outlet manifolds for the gases and cooling water. An oxidant gas supply pipe 11, a fuel gas supply pipe 12 and a cooling water supply pipe 15 are attached to one of the end plates so as to communicate with the oxidant gas inlet manifold, the fuel gas manifold and the cooling water manifold, respectively. An oxidant gas exhaust pipe 13, a fuel gas exhaust pipe 14 and a cooling water drain pipe 16 are attached to the other end plate so as to communicate with the corresponding outlet manifolds, respectively.

[0017]

The fuel cell is placed such that the cathode- and

anode-surfaces of the separator 1 are vertical and the cooling water inlet manifold hole 25 is positioned upward. As shown in FIG. 1, the oxidant gas supply pipe 11 is attached to the end plate such that it is positioned about one third from the top of the vertically oriented manifold hole 21. The gas flow channel 27 of the separator is designed such that the inlet thereof is positioned above the gas supply pipe 11. Also, the gas exhaust pipe 13 is connected to the end plate such that it is positioned at the same level as the outlet of the lower one of the two grooves serving as the gas flow channel. Though not shown, the positional relation between the gas supply pipe and the inlet of the separator's gas flow channel for the fuel gas and the relation between the exhaust pipe and the outlet of the separator's gas flow channel for the fuel gas are the same as those for the oxidant gas.

[0018]

≪Embodiment 2≫

FIG. 3 is a front view showing a cathode side of a separator according to this embodiment. This embodiment is the same as Embodiment 1 except that the connecting position of the oxidant gas supply pipe 11 with the end plate is about one tenth from the bottom of the manifold hole 21. The same numerals are given to the same components as those in Embodiment 1 and explanation thereof is omitted. This also applies to the rest of the figures.

[0019]

≪Embodiment 3≫

FIG. 4 is a front view showing a cathode side of a separator according to this embodiment. In a separator 1A, linear portions of an oxidant gas flow channel 27A are vertical. A gas supply pipe 11A and an exhaust pipe 13A are positioned in lower parts of manifold holes 21A and 23A, respectively. An inlet and an outlet of the gas flow channel 27A are positioned above the pipes 11A and 13A, respectively.

[0020]

≪Embodiment 4≫

FIG. 5 is a front view showing a cathode side of a separator according to this embodiment. A separator 1B includes an inlet manifold hole 21B and an outlet manifold hole 23B, both of which are L-shaped. A gas supply pipe 11B and an exhaust pipe 13B are positioned in lower parts of the manifold holes 21B and 23B, respectively. A gas flow channel 27B connecting the two manifold holes has an inlet and an outlet positioned above the pipes.

[0021]

≪Embodiment 5≫

FIG. 6 is a front view showing a cathode side of a separator according to this embodiment. A separator 1C has an oxidant gas inlet manifold hole 21C, an oxidant gas outlet manifold hole 23C, a gas flow channel 27C connecting the two manifold holes, a fuel gas inlet manifold hole 22C, a fuel gas outlet manifold hole 24C, a cooling water inlet manifold hole

25C and a cooling water outlet manifold hole 26C. An oxidant gas supply pipe 11C is positioned in a lower part of the manifold hole 21C, while an oxidant gas exhaust pipe 13C is positioned in a lower part of the manifold hole 23C. The gas flow channel 27C has an inlet positioned above the pipe 11C.

[0022]

≪Embodiment 6≫

FIG. 7 is a front view showing a cathode side of a separator of this embodiment. A separator 1D is the same as that in Embodiment 3, except that an oxidant gas outlet manifold hole 23D is shifted upward and that the position of a gas exhaust pipe 13D is almost the same as that of the outlet of the lower one of the two grooves serving as a gas flow channel 27A.

[0023]

[Working Examples]

Examples of the present invention are described below.

≪Example 1≫

On acetylene black type carbon powder, 25wt% of platinum particles having a mean particle diameter of about 30 Å were supported to prepare a cathode catalyst. Further, 25 wt% of platinum-ruthenium alloy particles having a mean particle diameter of about 30Å were supported on acetylene black type carbon powder to prepare an anode catalyst. Each of the catalyst powders was dispersed in isopropanol, which

was then mixed with a dispersion of perfluorocarbon sulfonic acid powder in ethyl alcohol to prepare a paste. These pastes were used as the raw materials, and each paste was applied to one side of nonwoven carbon cloth of 250 μm in thickness by screen printing, to form a catalyst layer. Each of the catalyst layers of the thus obtained electrodes contained 0.3 mg/cm^2 of catalytic metal and 1.2 mg/cm^2 of perfluorocarbon sulfonic acid.

[0024]

The obtained electrodes of cathode and anode were identically configured except the catalytic material. These electrodes were bonded by hot pressing to the center portions of both surfaces of a hydrogen ion conductive polymer electrolyte membrane having a slightly larger area, respectively, so that the printed catalyst layers were in contact with the electrolyte membrane. Further, a fluorocarbon rubber sheet of 250 μm in thickness was cut into a predetermined size and arranged to sandwich the electrolyte membrane exposed on the periphery of the electrodes. They were then joined integrally by hot pressing, to form an MEA. The hydrogen ion conductive polymer electrolyte membrane used was a 30 μm thick film of perfluorocarbon sulfonic acid.

[0025]

In this example, a conductive separator configured as explained in Embodiment 1 was used. A cell was placed so that the conductive separator surface was vertical to the

ground and the cooling water inlet manifold hole 25 was positioned upward. A reaction gas flows downward in the gravity direction along a serpentine gas flow channel including horizontal linear portions and curved portions. The separator was made of a 3-mm thick isotropic graphite plate, and a gas flow channel and manifold holes were formed therein by machining.

The conductive separators and the MEAs were stacked alternately. A cooling section for passing cooling water was provided every two MEAs. A stack of 50 MEAs was sandwiched between stainless steel end plates, with the intervention of a current collector plate made of a gold-plated copper plate and an insulating plate made of polyphenylene sulfide. The two end plates were secured by fastening rods. The fastening pressure at that time was 10 kgf/cm^2 per electrode area.

[0026]

As shown in FIG. 2, supply pipes were connected to one of the end plates of the fuel cell stack to supply reaction gases and cooling water to the respective manifolds in the fuel cell stack, while exhaust pipes were connected to the other end plate. However, the gases and cooling water may be supplied and exhausted from the same end plate by making a U-turn in the fuel cell stack.

[0027]

≪Comparative Example 1≫

FIG. 8 shows a conductive separator of a comparative

fuel cell. A separator 30 includes an oxidant gas inlet manifold hole 41, an oxidant gas outlet manifold hole 43, a fuel gas inlet manifold hole 42, a fuel gas outlet manifold hole 44, a cooling water inlet manifold hole 45 and a cooling water outlet manifold hole 46. The separator 30 further includes a gas flow channel 47 comprising two parallel grooves connecting the manifold holes 41 and 43 on the cathode side and another gas flow channel connecting the manifold holes 42 and 44 on the anode side. As shown in FIG. 8, an oxidant gas supplied from an oxidant gas supply pipe 31 to the inlet manifold 41 positioned in an upper part of the separator 30 flows downward in the gravity direction and exhausted through the outlet manifold hole 43 to a gas exhaust pipe 33. In a like manner, a fuel gas flows from the inlet manifold hole 42 through the gas flow channel and is exhausted through the outlet manifold hole 44 to an exhaust pipe.

[0028]

The solid polymer type fuel cells of Example 1 and Comparative Example 1 were kept at 75℃. Then, a fuel gas (80% hydrogen gas/ 20% carbon dioxide/ 10 ppm carbon monoxide) heated and humidified to have a dew point of 75℃ was supplied to the anode, and air heated and humidified to have a dew point of 75℃ was supplied to the cathode, to perform rated operation. The rated cell operation was carried out under the conditions of the fuel utilization ratio of 75%, the oxygen utilization ratio of 40% and the current density of 0.3 A/cm^2.

FIG. 9 compares cell voltages of the respective cells in such operation. The horizontal axis of FIG. 9 represents the cell number counted from the gas inlet side.

[0029]

The cell of Comparative Example 1 showed an irregular decrease in performance of the unit cells of low number close to the inlet gas supply pipe. The cell of Comparative Example 1 was configured so that the gas was supplied to the gas flow channel of the separator from the lower part of the inlet manifold. Accordingly, part of the highly humidified supplied gas condensed in the upstream of the stack, and the condensed water flowed into the gas flow channels of the unit cells of low number close to the gas supply pipe. Consequently, flooding occurred and hence the performance decreased. On the other hand, in the cell of Example 1, the connecting position of the gas flow channel with the manifold hole was set above the position of the gas supply pipe connected to the inlet reaction gas manifold hole of the separator in the gravity direction. Therefore, the mist was temporarily trapped in the manifold hole, avoiding the concentrated supply of mist. Accordingly, it was confirmed that this example was effective.

[0030]

≪Comparative Example 2≫

In this comparative example, the fuel cell stack of Example 1 was placed such that the separator surface was

horizontal, i.e., the end plates were positioned upward and downward in the gravity direction. Then, a rated power generation test was performed by supplying gases from the upper end plate of the stack and discharging the gases from the lower end plate of the stack. As a result, the voltages of several lower cells tended to lower irregularly. This is attributable to the flooding that was caused by mist included in the supply gas, or that was caused when water produced by condensation in the stack inlet side of the manifold flowed in the lower part of the manifold and occasionally entered the gas flow channels of the cells. Even when the arrangement of the gas supply pipe and the gas exhaust pipe was reversed, the voltages of several lower cells tended to lower in the same manner. In this way, when the separators were placed in a horizontal position, water produced by condensation in the upstream of the cell stack was retained on the bottom of the supply manifold, and the condensed water was directly supplied to the gas flow channels of the cells, thereby causing flooding. As described, when the separators are placed in a horizontal position, the gas supply inlet manifold is strongly affected by condensed water.

In contrast, as in Example 1, when the cell is placed and operated such that the separators are vertical, all the unit cells maintain stable performance. Therefore, by placing the separators in a vertical position, operation stability becomes high.

[0031]

≪Example 2≫

A cell was produced in which the gas supply pipe connected to the inlet manifold was positioned about one tenth of the vertical length of the manifold from the bottom of the manifold, as in Embodiment 2, i.e., the cathode-side separator of FIG. 3. Except this, the configuration was the same as that of Example 1. FIG. 10 shows the results of continuous operation of the cells of this example and Example 1 under the rated operation conditions.

[0032]

In the cell of Example 1, the cell performance fluctuated, occasionally exhibiting a phenomenon of a momentary drop in cell voltage. On the other hand, the cell of this example showed stable performance. In the cell of Example 1, since the gas supply pipe is positioned one third from the top of the manifold, condensed water in the gas supply pipe was retained in the lower part of the manifold. The retained water caused fluctuation of the supply gas pressure, and the retained water was irregularly supplied to the gas flow channel, thereby temporarily blocking the gas flow channel of the cell. As a result, the cell voltage dropped. Further, in the cell of Example 1, because of the retention of e.g. the condensed water in the manifold, the pressure loss in the gas flow channels in the whole fuel cell stack was actually larger than the set value by 30%, which

decreased the efficiency of the whole fuel cell system. On the other hand, in the cell of this example, the pressure loss was the same as the set value, and it was confirmed that the cell was capable of operation without causing the problem of the water retention in the manifold.

[0033]

Also, the unstable phenomenon due to water retention did not occur as long as the gas supply pipe connected to the manifold was positioned anywhere below the center of the manifold.

In this example, the gas flowed downward in the gravity direction and the manifold was vertically oriented. However, it was confirmed that stable fuel cell performance could be obtained with use of a separator of FIG. 4 configured to pass the gas upward in the gravity direction or separators of FIGs. 5 and 6 having manifolds of different shapes.

[0034]

≪Example 3≫

In this example, a cell was produced, using the separator of Embodiment 6, i.e., the separator of FIG. 7. After the rated operation, it was confirmed that this cell was capable of providing stable performance for a longer time than the cell of Example 2. In the cell of Example 2, the outlet of the gas flow channel communicated with the upper part of the outlet manifold. Therefore, condensed water and generated water were temporary retained in the lower part of the

manifold during continuous operation, so that the cell performance became unstable due to the fluctuation of the reaction gas pressure in the stack. However, in the cell of this Example, the outlet of the gas flow channel and the connecting position of the gas exhaust pipe with the manifold were provided in the lower part of the manifold. Therefore, the retention of condensed water or generated water was constantly prevented by making use of dynamic pressure of unreacted gas, which allowed stable exhaustion of the gas and water.

[0035]

Also, when the position of the gas exhaust pipe for exhausting the unreacted gas from the outlet manifold to the outside of the stack was changed to the center of the manifold of the cell stack adopting the separator of FIG. 7, condensed water and generated water were clearly retained in the lower part of the manifold, making the cell performance unstable. In the cell of this example, since the gas exhaust pipe was provided in the lower part of the manifold, the water retention did not occur, and the cell performance was stable.

[0036]

In the foregoing Examples, regarding the cathode side and the anode side, the gas supply pipe, the inlet of the gas flow channel of the separator and the inlet manifold are arranged in a certain positional relationship, and further, the gas exhaust pipe, the outlet of the gas flow channel of

the separator and the manifold are arranged in a certain positional relationship. However, similar degree of effect is obtained even if such a positional relationship is established only on the anode side or the cathode side. Although the Examples have been explained by referring to a fuel cell of internal manifold type, the invention is also applicable to a cell of external manifold type.

[0037]

[Effects of the Invention]

According to the present invention as described above, uniform gas supply to all the unit cells in a cell stack is achieved, and retention of condensed water in a manifold is avoided. Thus, gas can be supplied stably, and cell performance is prevented from becoming deteriorated or unstable. Accordingly, the reliability of the fuel cell can be improved.

[BRIEF EXPLANATION OF THE DRAWINGS]

[FIG.1]

A front view showing a cathode side of a conductive separator used in a fuel cell of Embodiment 1 of the present invention.

[FIG. 2]

A side view showing the fuel cell of Embodiment 1 of the present invention.

[FIG. 3]

A front view showing a cathode side of a conductive

separator used in a fuel cell of Embodiment 2 of the present invention.

[FIG. 4]

A front view showing a cathode side of a conductive separator used in a fuel cell of Embodiment 3 of the present invention.

[FIG. 5] is a front view showing a cathode side of a conductive separator used in a fuel cell of Embodiment 4 of the present invention.

[FIG. 6]

A front view showing a cathode side of a conductive separator used in a fuel cell of Embodiment 5 of the present invention.

[FIG. 7]

A front view showing a cathode side of a conductive separator used in a fuel cell of Embodiment 6 of the present invention.

[FIG. 8]

A front view showing a cathode side of a conductive separator used in a fuel cell of Comparative Example.

[FIG. 9]

A graph comparing cell voltages of the fuel cells of Example 1 and Comparative Example 1.

[FIG. 10]

A graph showing variation in voltage of the fuel cells of Examples 1 and 2 of the present invention and

Comparative Example 1 during continuous operation.

[Explanation of Reference Numerals]

1 Conductive separator

2 MEA

3 Current collector plate

4 Insulating plate

5 End plate

6 Clamping rod

11 Oxidant gas supply pipe

12 Fuel gas supply pipe

15 Cooling water supply pipe

13 Oxidant gas exhaust pipe

14 Fuel gas exhaust pipe

16 Cooling water exhaust pipe

21 Oxidant gas inlet manifold hole

22 Fuel gas inlet manifold hole

25 Cooling water inlet manifold hole

23 Oxidant gas outlet manifold hole

24 Fuel gas outlet manifold hole

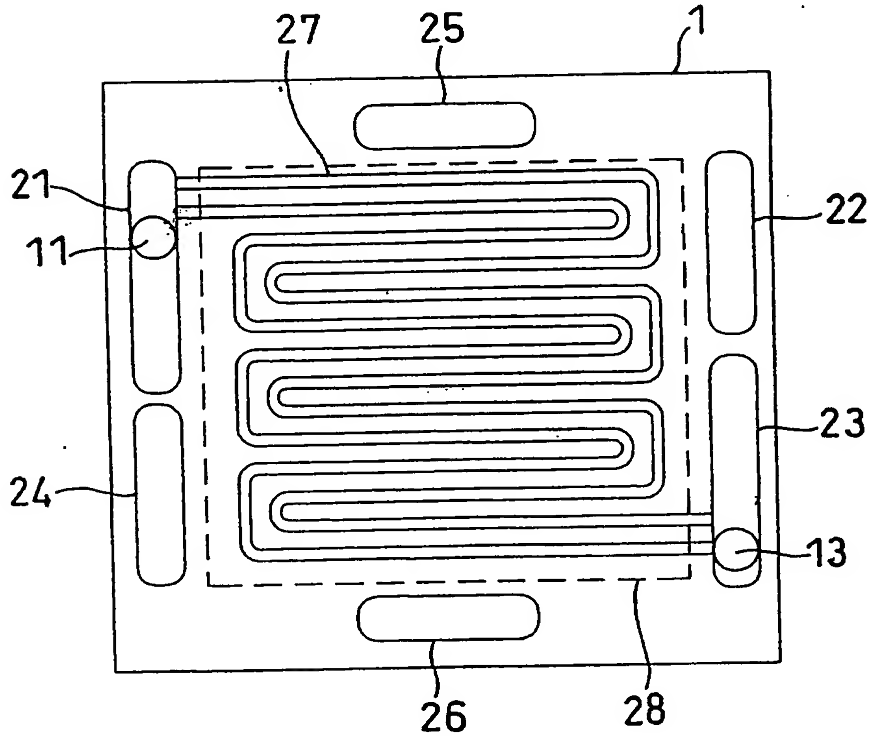
26 Cooling water outlet manifold hole

27 Oxidant gas flow channel

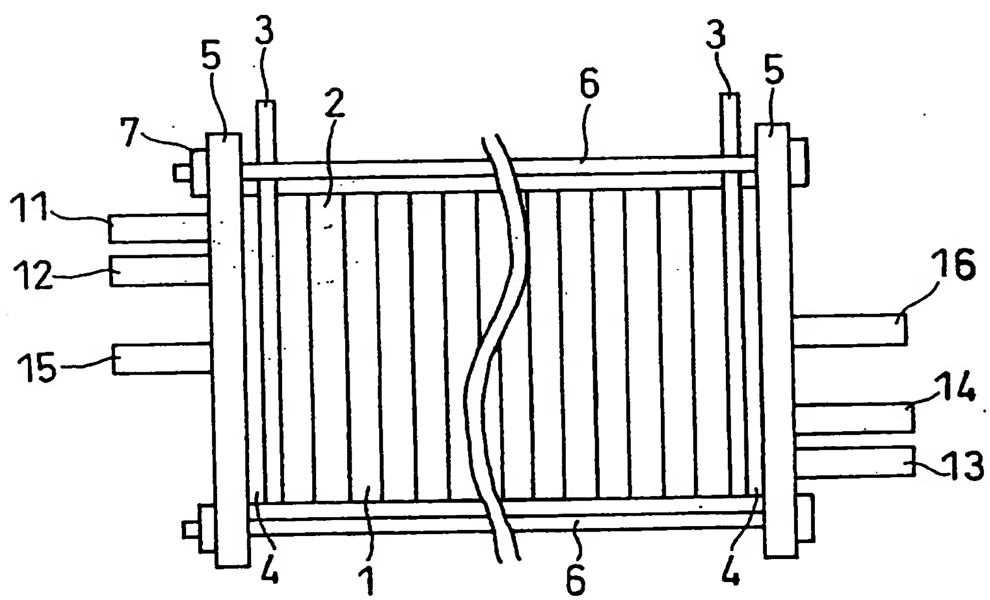
28 Electrode area

【書類名】　図面　[DOCUMENT NAME] Drawings

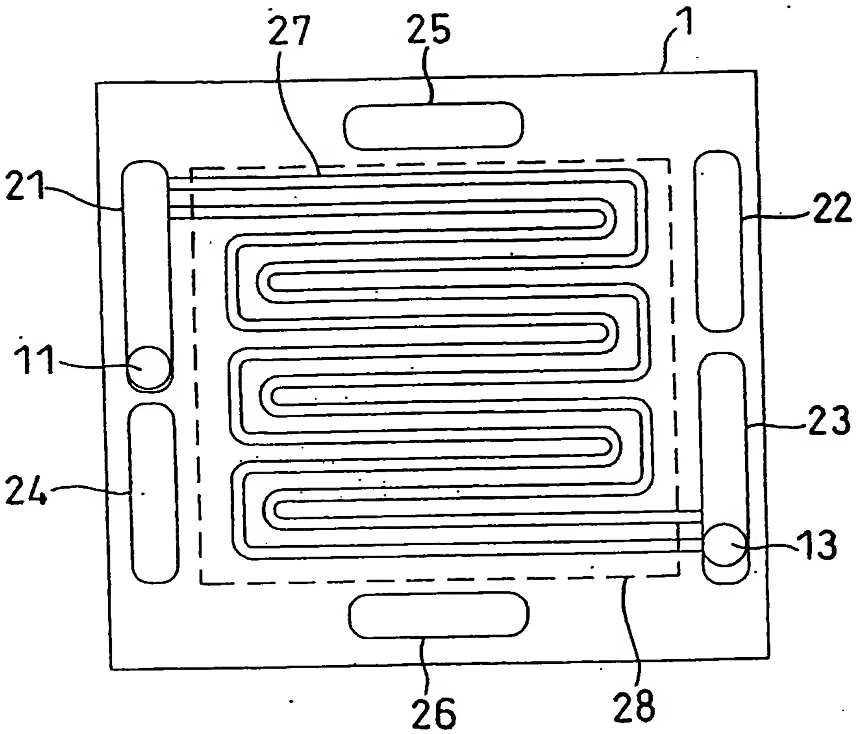
【図１】 [FIG. 1]



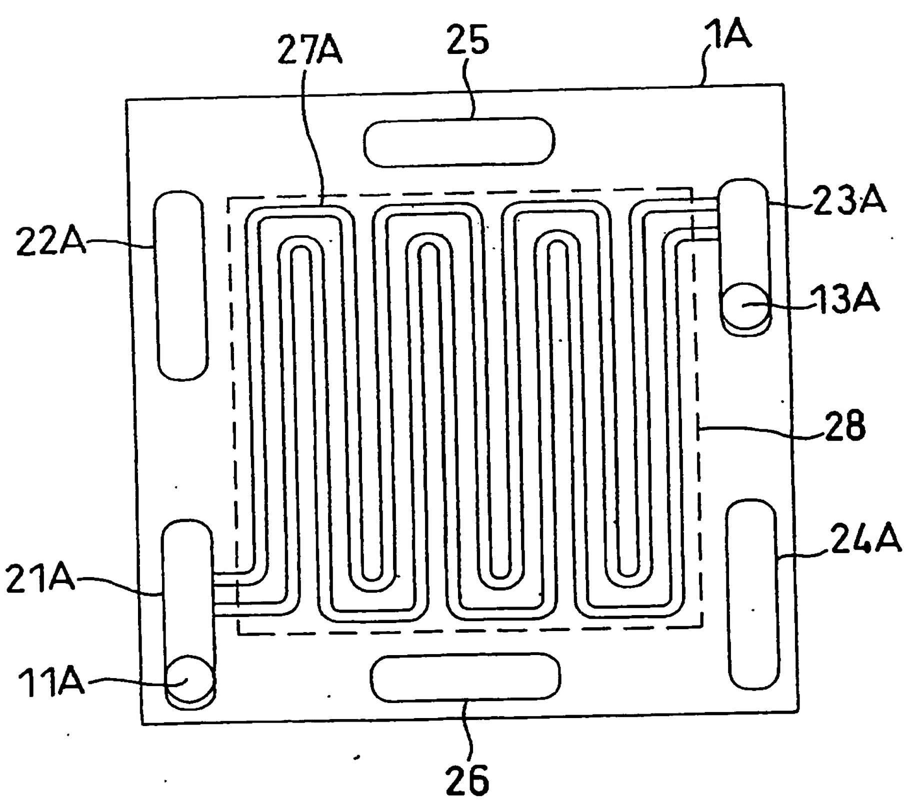
【図２】 [FIG. 2]



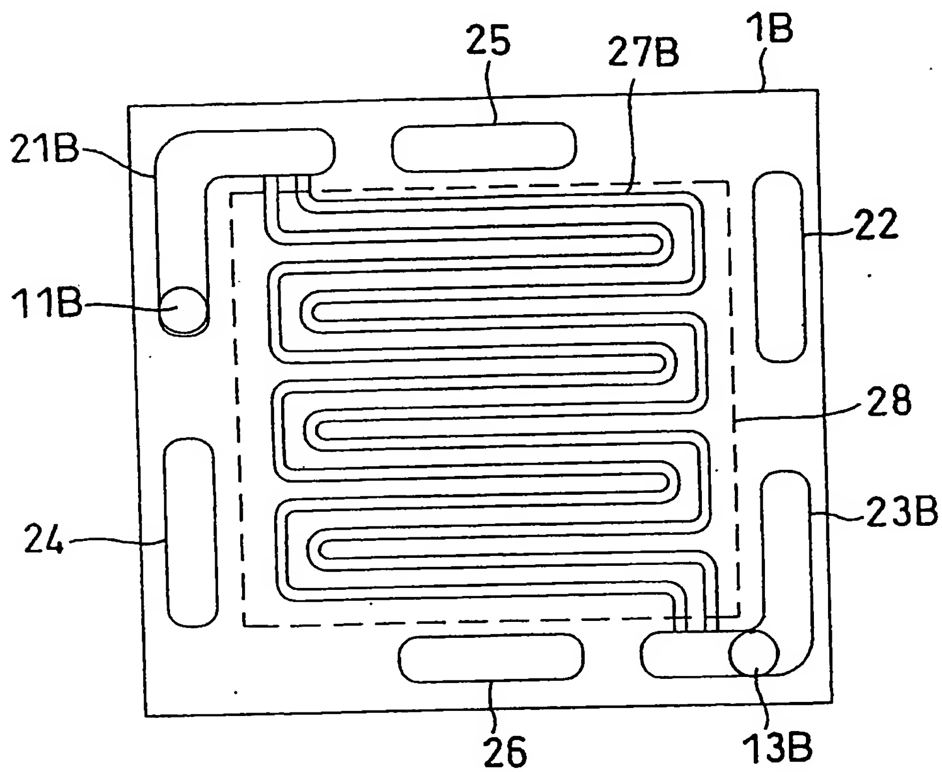
【図３】　[FIG. 3]



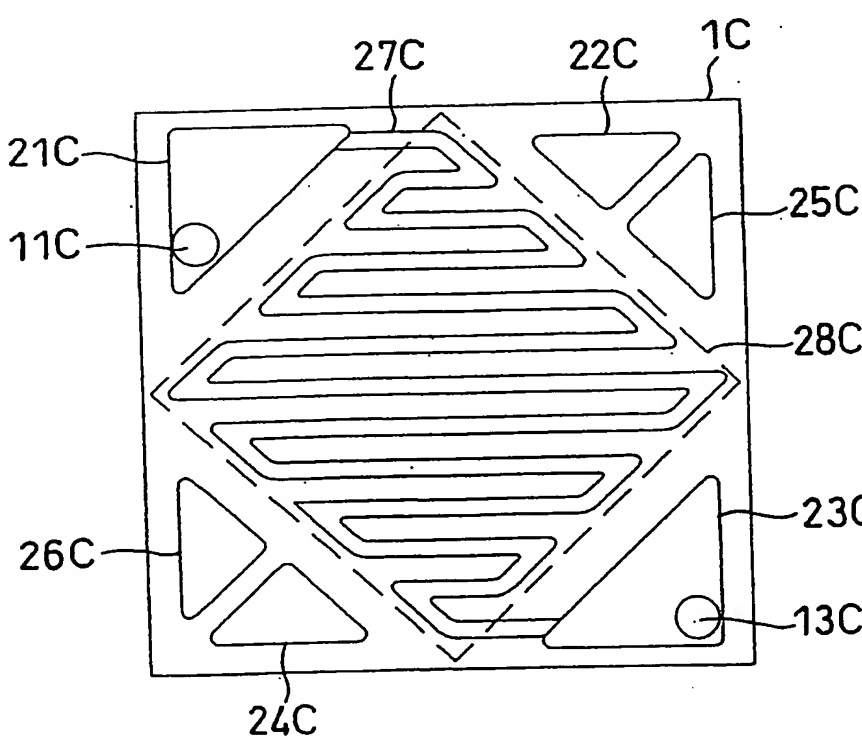
【図４】　[FIG. 4]



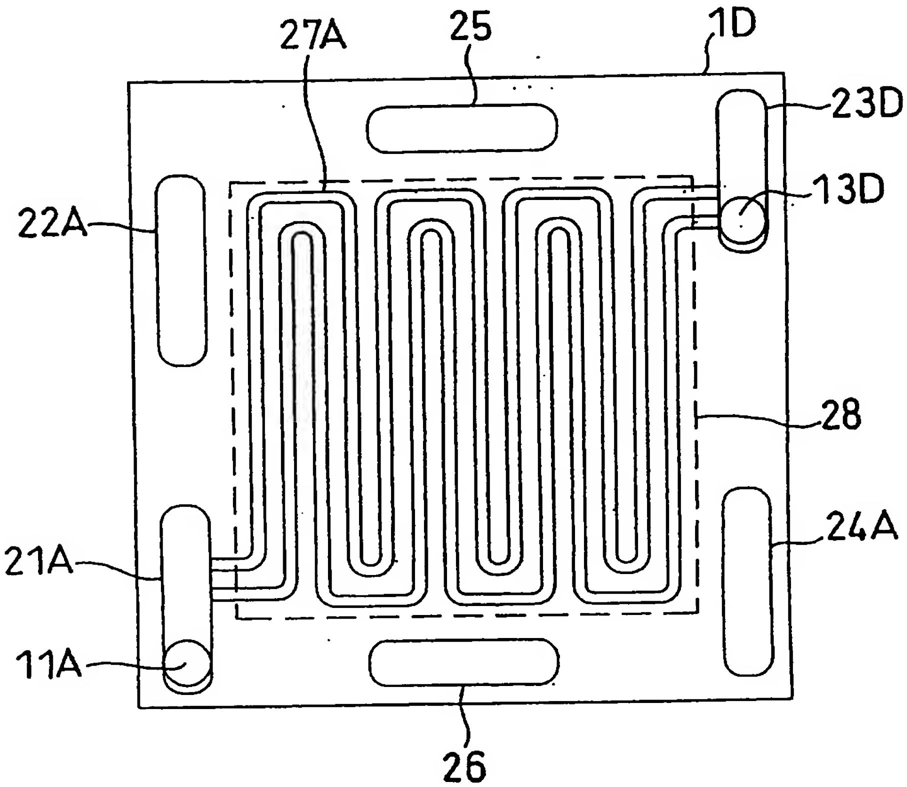
【図５】 [FIG. 5]



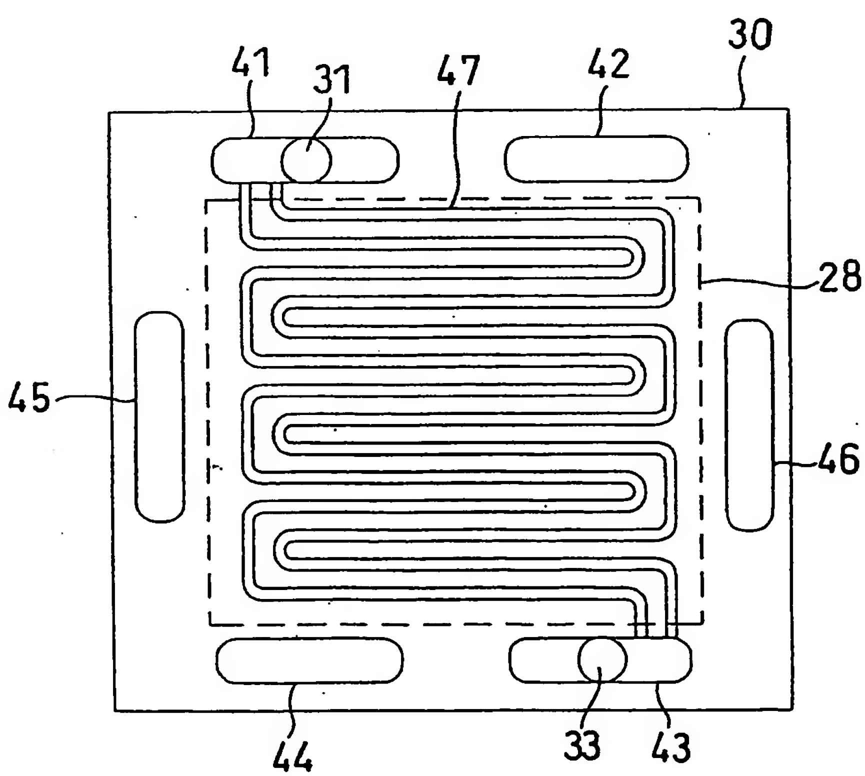
【図６】 [FIG. 6]



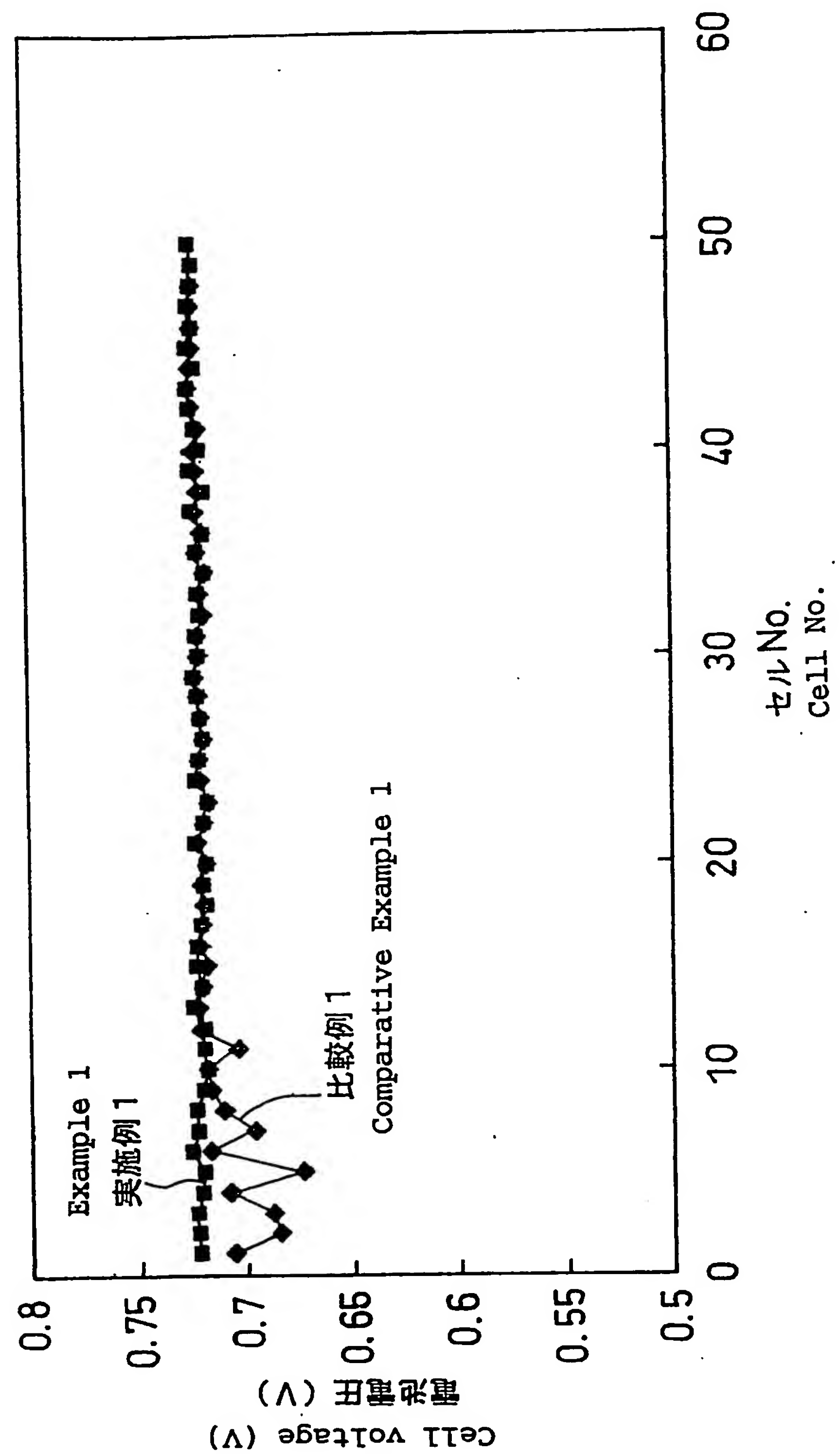
【図７】［FIG. 7］



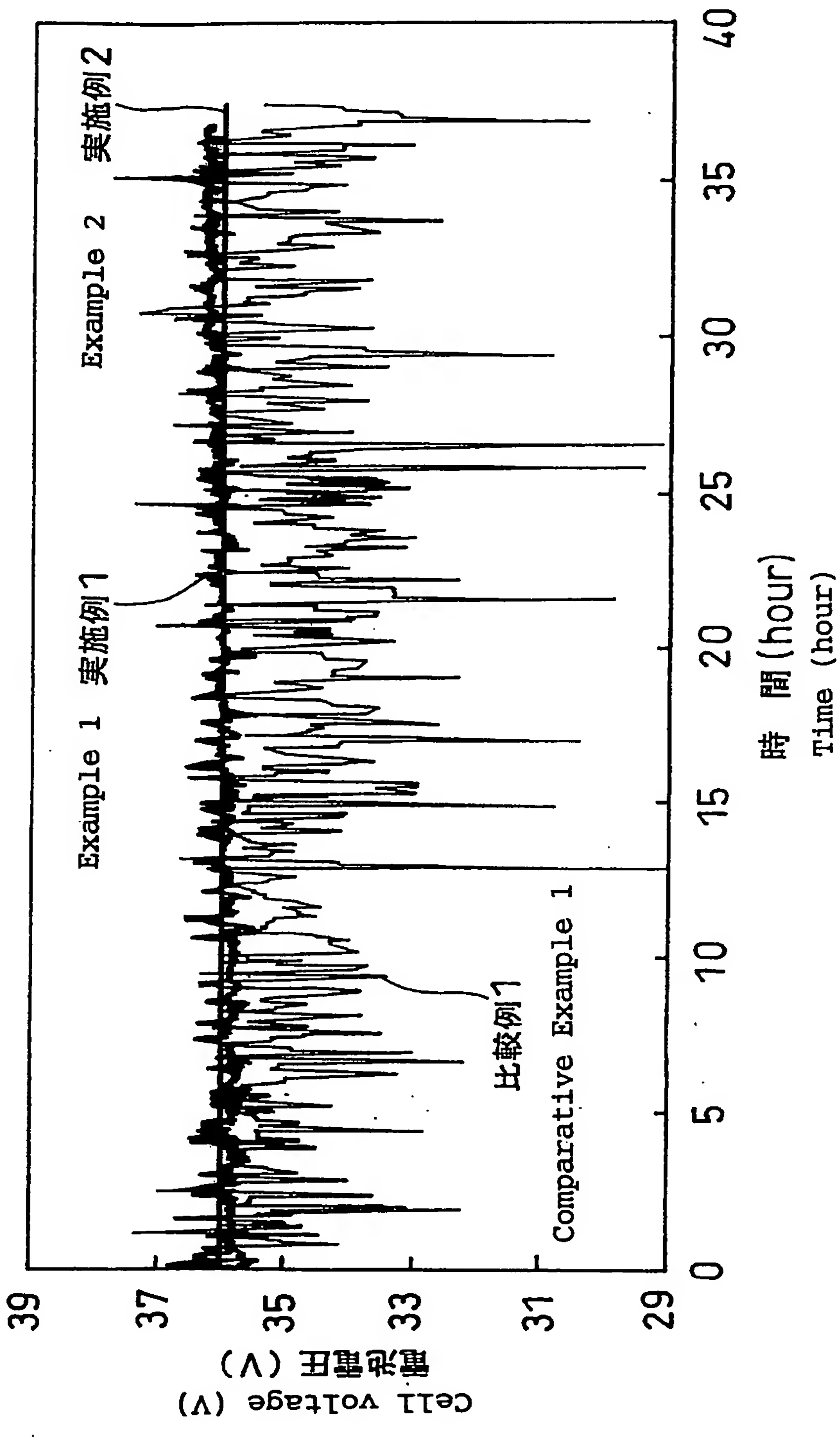
【図８】［FIG. 8］



【図９】［FIG. 9］


Example 1
実施例１
比較例１
Comparative Example 1
電池電圧（V）
Cell voltage (V)
セルNo.
Cell No.
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0
10
20
30
40
50
60

【図１０】 [FIG. 10]


実施例２
Example 2
実施例１
Example 1
比較例１
Comparative Example 1
時　間(hour)
Time (hour)
電池電圧 (V)
Cell voltage (V)
0
5
10
15
20
25
30
35
40
39
37
35
33
31
29

2003-104917

(Translation)

[DOCUMENT NAME] Abstract

[ABSTRACT]

[OBJECTIVE] Conventional separator shapes have problems in that mist is partially included in a supply gas, thereby making cell performance deteriorated or unstable.

[SOLVING MEANS] A solid polymer type fuel cell has a cell stack including: hydrogen ion conductive polymer electrolyte membrane; a pair of electrodes sandwiching the polymer electrolyte membrane; and a pair of conductive separators having a gas flow channel for supplying and exhausting a fuel gas to and from one of the electrodes and a gas flow channel for supplying and exhausting an oxidant gas to and from the other electrode. The junction of at least one of the fuel and oxidant gas flow channels of the conductive separators with an inlet manifold is positioned above a gas supply pipe connected to the manifold in the gravity direction.

[SELECTED DRAWING] FIG. 1